

The Ford/DOE Hybrid Propulsion Systems Development Program

In December 1993 Ford Motor Company began its cost-shared, five-year Hybrid Propulsion Systems Development Program. The objective of this \$120 million contract with the U.S. Department of Energy (DOE) is to develop and demonstrate a production-feasible hybrid propulsion system in a vehicle that incorporates advanced propulsion, control, and energy storage technologies, while meeting market requirements for cost, safety, and performance.

According to Ford Program Manager Gary Stokes, the Ford team is dividing the effort into four phases.

- *Study/Definition Phase.* Ford determined the configuration of their ultimate hybrid electric vehicle (HEV) product based on an evaluation of existing technologies and relationships between the major components of candidate vehicles.
- *System and Component Design Phase.* Ford will verify first-phase assumptions and prepare to build the propulsion systems and test vehicles.
- *Component Build/Test Phase.* Required components will be built and tested; mule vehicles also will be designed and built.
- *Systems Integration/Vehicle Test Phase.* Components will be integrated into a total vehicle system, and the vehicles will be tested and assessed as to their production viability.

Vehicles delivered to DOE as a result of this program are targeted to have fuel efficiency twice that of a comparable current production vehicle, and produce emissions that meet Federal Tier II standards. Currently, Ford's analysis suggests that the team will be developing both series and parallel hybrid propulsion systems prototypes. State-of-the-art technology in gas turbines and compression ignition engines are candidates for the power source. ultracapacitors, flywheels, and high-power, bi-polar lead acid batteries are among the candidates for energy storage for these prototype systems. As part of the effort, Ford is partnering with a number of independent companies expert in chosen scientific and supporting areas. To date, these partners include:

AlliedSignal Aerospace Company	gas turbine hybrid power units (HPUs)
A.D. Little Company	fuels, infrastructure studies
Chevron	fuels, infrastructure
FEV Engine Technology	direct-injection engines
General Electric Corporate R&D	ultracapacitors
GNB Industrial	bi-polar lead-acid batteries
Johnson Controls	batteries
Mooradian Associates	cost analysis
Teledyne Ryan Aeronautical	gas turbine HPU
Unique Mobility, Inc.	flywheels

Partners have and are expected to continue changing over time as the needs of the effort evolve. All team members are sharing costs in the effort.

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